CLAIMS

1. A method for reconstructing surfaces from a single or a plurality of arbitrary three-dimensional entities obtained from a target surface, comprising:

(a) obtaining a set of at least one three-dimensional entity, each entity being a set of three-dimensional points, each three-dimensional point containing at least the three-dimensional coordinates of said point on said target surface;

(b) constructing a volumetric implicit representation of said target surface in the form of a vector field, each vector in said vector field containing at least the distance to said reconstructed surface and the direction toward said reconstructed surface;

(c) placing each three-dimensional entity in said vector field and updating said vector field accordingly; and

(d) reconstructing said target surface from the information contained in said vector field.

2. The method according to claim 1, wherein at least one of the three-dimensional entities is an unorganized cloud of three-dimensional points.

3. The method according to claim 1, wherein at least one of the three-dimensional entities is an organized set of three-dimensional points that are part of one or a plurality of three-dimensional curves.

4. The method according to claim 1, wherein:

at least one of the three-dimensional entities is an unorganized cloud of three-dimensional points; and

at least one of the three-dimensional entities is an organized set of three-dimensional points that are part of one or a plurality of three-dimensional curves.

5. The method according to claim 1, wherein:

at least one of the three-dimensional entities is a range image, said range image being a matrix of three-dimensional points; and

at least one of the three-dimensional entities is an unorganized cloud of three-dimensional points.

6. The method according to claim 1, wherein:

at least one of the three-dimensional entities is a range image, said range image being a matrix of three-dimensional points; and

at least one of the three-dimensional entities is an organized set of three-dimensional points that are part of one or a plurality of three-dimensional curves.

7. The method according to any one of claims 1 to 6, wherein a subset of three-dimensional point contains surface properties measured on said target surface.

8. The method according to any one of claims 1 to 7 wherein at least one of said properties measured on said target surface is a grayscale value associated to said three-dimensional point.

9. The method according to any one of claims 1 to 7 wherein at least one of said surface properties measured on said target surface is a color information associated to said three-dimensional point.

10. The method according to any one of claims 1 to 7 wherein at least one of said surface properties measured on said target surface is an information describing the surface texture associated to said three-dimensional point.

11. A method for refining the alignment of arbitrary three-dimensional entities obtained from a target surface, comprising:

(a) obtaining a set of at least two three-dimensional entities, each entity being a set of three-dimensional points, each three-dimensional point containing at least the three-dimensional coordinate of said point on said target surface;

(b) constructing a volumetric implicit representation of said target surface in the form of a vector field, each vector in said vector field containing at least the distance to the reconstructed surface and the direction toward said reconstructed surface;

(c) placing at least two three-dimensional entities in said vector field and updating said vector field accordingly;

(d) selecting at least one three-dimensional entity placed in said vector field and obtaining a subset of three-dimensional points on each of said selected three-dimensional entities, three-dimensional points in these subsets being called control points;

(e) for each control point in each selected three-dimensional entity, computing a contribution to a cost function, said contribution being a function of at least said vector field and said three-dimensional coordinate of said control point;

(f) for each selected three-dimensional entity, computing a new position that optimizes its corresponding cost function; and

(g) placing each selected three-dimensional entity in said vector field at its newly computed position and updating said vector field accordingly.

12. The method according to claim 11 wherein steps (d), (e), (f) and (g) are repeated until a set of convergence criteria is met.

13. A method for refining the alignment of arbitrary three-dimensional entities obtained from a target surface, comprising:

(a) obtaining a set of at least two three-dimensional entities, each entity being a set of three-dimensional points, each three-dimensional point containing at least the three-dimensional coordinate of said point on said target surface;

(b) constructing a volumetric implicit representation of said target surface in the form of a vector field, each vector in said vector field containing at least the distance to the reconstructed surface and the direction toward said reconstructed surface;

(c) placing at least one three-dimensional entity in said vector field and updating said vector field accordingly;

(d) selecting at least one of said three-dimensional entities not yet placed in said vector field, placing said selected three-dimensional entities in said vector field without updating said field and obtaining a subset of three-dimensional points on each of said selected three-dimensional entities, three-dimensional points in these subsets being called control points;

(e) for each control point in each selected three-dimensional entity, computing a contribution to a cost function, said contribution being a function of at least said vector field and said three-dimensional coordinate of said control point;

(f) for each selected three-dimensional entity, computing a new position that optimizes its corresponding cost function; and

(g) placing each selected three-dimensional entity in said vector field at its newly computed position and updating said vector field accordingly.

14. The method according to claim 13 wherein steps (d), (e), (f) are repeated until a set of convergence criteria is met.

15. The method according to any one of claims 11 to 14, wherein a subset of three-dimensional point contains surface properties measured on said target surface.

16. The method according to claim 15, wherein said cost function is a function of said surface properties measured on said target surface.

17. The method according to any one of claims 11 to 16, wherein at least one of said three-dimensional entities is an unorganized cloud of three-dimensional points.

18. The method according to any one of claims 11 to 16, wherein at least one of said three-dimensional entities is an organized set of three-dimensional points that are part of one or a plurality of three-dimensional curves.

19. The method according to any one of claims 11 to 16, wherein:

at least one of said three-dimensional entities is an unorganized cloud of three-dimensional points; and

at least one of said three-dimensional entities is an organized set of three-dimensional points that are part of one or a plurality of three-dimensional curves.

20. The method according to any one of claims 11 to 16, wherein:

at least one of said three-dimensional entities is a range image, said range image being a matrix of three-dimensional points; and

at least one of said three-dimensional entities is an unorganized cloud of three-dimensional points.

21. The method according to any one of claims 11 to 16, wherein:

at least one of said three-dimensional entities is a range image, said range image being a matrix of three-dimensional points; and

at least one of said three-dimensional entities is an organized set of three-dimensional points that are part of one or a plurality of three-dimensional curves.

22. The method according to any one of claims 11 to 21 wherein at least one of said surface properties measured on said target surface is a grayscale value associated to said three-dimensional point.

23. The method according to any one of claims 11 to 21 wherein at least one of said surface properties measured on said target surface is a color information associated to said three-dimensional point.

24. The method according to any one of claims 11 to 21 wherein at least one of said surface properties measured on said target surface is an information describing the surface texture associated to said three-dimensional point.

25. A method for ascertaining the three-dimensional shape of a target surface, comprising:

using a ranging sensor to produce a set of three-dimensional entities; and

using a method according to any one of claims 1 to 7 to reconstruct said target surface.

26. A method according to claim 25 further comprising using a method according to any one of claims 11 to 24 to improve the quality and accuracy of said reconstructed surface.

27. The method of any one of claims 25 to 26 wherein said ranging sensor is held in hand by an operator.

28. The method of any one of claims 25 to 27 wherein said ranging sensor is moved by a mechanical device.

29. The method of any one of claims 1 to 28, wherein said three-dimensional points are all measured in a single plane and the coordinate system can be reduced to a two-dimensional system.

30. A system for reconstructing surfaces from a single or a plurality of arbitrary three-dimensional entities obtained from a target surface comprising:

a three-dimensional entity provider for obtaining a set of at least one three-dimensional entity, each entity being a set of three-dimensional points, each three-dimensional point containing at least the three-dimensional coordinates of the point on the target surface;

an implicit representation constructor

for constructing a volumetric implicit representation of the target surface in the form of a vector field, each vector in the vector field containing at least the distance to the reconstructed surface and the direction toward the reconstructed surface;

for placing each three-dimensional entity in the vector field; and

for updating the vector field accordingly; and

a target surface reconstructor for reconstructing the target surface from the information contained in the vector field.

31. A system as claimed in claim 30, further comprising:

a ranging sensor to produce said set of three-dimensional entities.

32. A system for refining an alignment of arbitrary three-dimensional entities obtained from a target surface, comprising:

a three-dimensional entity provider for obtaining a set of at least two three-dimensional entity, each entity being a set of three-dimensional points, each three-dimensional point containing at least the three-dimensional coordinates of the point on the target surface;

an implicit representation constructor

for constructing a volumetric implicit representation of the target surface in the form of a vector field, each vector in the vector field containing at least the distance to the reconstructed surface and the direction toward the reconstructed surface;

for placing at least two three-dimensional entity in the vector field; and

for updating the vector field accordingly; and

a control point selector for selecting at least one three-dimensional entity placed in the vector field and obtaining a subset of three-dimensional points on each of the selected three-dimensional entities, three-dimensional points in these subsets being called control points;

a cost function calculator for computing, for each control point in each selected three-dimensional entity, a contribution to a cost function, the contribution being a function of at least the vector field and the three-dimensional coordinate of the control point;

a new position calculator for computing, for each selected three-dimensional entity, a new position that optimizes its corresponding cost function.

wherein the implicit representation constructor places each selected three-dimensional entity in the vector field at its newly computed position and updates the vector field accordingly.

33. A system for refining an alignment of arbitrary three-dimensional entities obtained from a target surface, comprising:

a three-dimensional entity provider for obtaining a set of at least two three-dimensional entity, each entity being a set of three-dimensional points, each three-dimensional point containing at least the three-dimensional coordinates of the point on the target surface;

an implicit representation constructor

for constructing a volumetric implicit representation of the target surface in the form of a vector field, each vector in the vector field containing at least the distance to the reconstructed surface and the direction toward the reconstructed surface;

for placing at least one three-dimensional entity in the vector field; and

for updating the vector field accordingly; and

a control point selector

for selecting at least one of the three-dimensional entities not yet placed in the vector field, wherein the implicit representation constructor places the selected three-dimensional entities in the vector field without updating the field,

and obtaining a subset of three-dimensional points on each of the selected three-dimensional entities, three-dimensional points in these subsets being called control points;

a cost function calculator for computing, for each control point in each selected three-dimensional entity, a contribution to a cost function, the contribution being a function of at least the vector field and the three-dimensional coordinate of the control point;

a new position calculator for computing, for each selected three-dimensional entity, a new position that optimizes its corresponding cost function.

wherein the implicit representation constructor places each selected three-dimensional entity in the vector field at its newly computed position and updates the vector field accordingly.